


Pick Tennessee Products  
Farm and Restaurant Alliance  
Local Sourcing Guide





Tennessee Department of Agriculture, Authorizaton No. 325465, 750 copies, August 2015. This public document was promulgated at a cost of \$5.48 per copy.



The **Tennessee Department of Agriculture (TDA)** is proud to offer the Pick Tennessee Products Farm and Restaurant Alliance. Designed to foster relationships between Tennessee's foods service operations and Tennessee farmers, this marketing and outreach campaign increases the visibility of locally grown food on Tennessee restaurant menus.

Restaurant food buyers (usually the “chef”) often struggle alone to increase the amount of locally grown items on their menus. Under the Pick TN Products umbrella, the Farm and Restaurant Alliance can open the door for both industries to connect and work together to increase the availability of local foods for the dining consumers. This effort will provide the education, connection, and promotion needed to make local sourcing more functional.

**Program Staff:**

Linda Shelton, Program Development and Outreach  
Amy Tavalin, Program Development and Outreach  
Cynthia Kent, Advertising and Media  
Art Colebank, Art Design

**Farm and Restaurant Alliance Advisory Committee:**

Tana Comer	Eaton's Creek Organic Farm
Steve Guttery	Tennessee Association of Farmers Markets
Melissa McIntyre	Tennessee Hospitality & Tourism Association
Sylvia Ganier	Green Door Gourmet
Debbie Ball	Tennessee Department of Agriculture
Melissa Corbin	Corbin In The Dell
Chef Susan Moses	212 Market
Dave Jones	Tennessee Department of Tourism
Chef Rick Wright	Sewanee - The University of the South
Tyler Sneed	Red River Farms
Kent Yarnall	Old Mill

*Funding Provided By: Tennessee Department of Agriculture and USDA Specialty Crop Block Grant Program*



# What is “Pick Tennessee Products?”

**Pick Tennessee Products** is part of the Tennessee Department of Agriculture, which means that we are a not-for-profit service dedicated to connecting people everywhere to Tennessee farms, farmers, farmers markets and all the great things that come from our farms and food businesses. We do not charge anyone for our services or generate income for any agency.



Right now, Pick Tennessee can help you find about 2,200 individual Tennessee farmers and farm-direct businesses who list almost 10,000 farm products! You can use Pick Tennessee on the Web, Facebook and Twitter to find anything fresh, local, fun or festive related to a farm.

From produce to pumpkin patches, from honey and handmade soaps to farm direct cheeses and artisan chocolates, from farm-milled corn meal to making meals with our seasonal recipes, you can live local better with Pick Tennessee.

Farmers/producers of fresh agricultural products are eligible for inclusion in the PTP program and can apply online. Listing products on Pick Tennessee Products is free for producers.

Pick Tennessee Products has helped consumers identify locally grown, processed and crafted products since 1986. Last year, there were more than 315,000 visits to the program's Web site.

The demand for local products is growing all the time. Access to fresh and local products allows consumers to enjoy the nutritional, environmental and economic benefits of foods they choose, use and preserve themselves.

To be included, farmers/food producers must be in compliance with all permits, licenses and inspections administered by the TDA Consumer and Industry Services division and go through an application process. The program offers exposure and marketing opportunities to producers who are just starting out or who have been in the business for a while but do not have access to the proper business resources.

For many Pick Tennessee producers, this is their only Web presence. The increasing number of farms, food businesses and items listed on the site tell us loyal customers are supporting our participants.

**Visit us at [www.PickTNProducts.org](http://www.PickTNProducts.org), and  
follow us on Facebook, Twitter, Instagram and Pinterest!**



# Table of Contents

## Tips for Farmers and Producers

Why Should You Sell To Restaurants? .....	7
Tips For Direct Sales To Restaurants .....	8
Key Questions To Ask Yourself .....	9
Advice For Farmers .....	10
Important Reminders For Farmers .....	11

## Tips for Chefs and Restaurants

Why Should Chefs Purchase From Local Producers? .....	15
Marketing Local Ingredients To Your Customers .....	16
Tips For Direct Purchases From Farmers .....	17
Advice For Chefs .....	18
Topics to Discuss With Producers .....	19
Procurement Checklist .....	20
Important Reminders For Food Buyers .....	22
Avenues To Find Locally Grown Ingredients .....	23
Food Safety .....	24
The Beginners Guide to Local Source Menu Planning .....	25

## Appendix

Farm Measurements .....	28
Kitchen Equivalents .....	29
Tennessee Seasonality Chart .....	30
Farming Terms .....	32
Food Processing Terms .....	34
Sample Standard Operatin Procedures (SOPs) .....	35
ATTRA – <i>Postharvest Handling of Fruits and Vegetables</i> .....	36



**NOTES:**

Lined area for notes, consisting of 20 horizontal lines.



# Tips for Farmers/Producers



# Why Should You Sell to Restaurants?

## Advantages:

Chefs value fresh, high quality products delivered from your farm to their door and are willing to pay top dollar for those items.

## Considerations:

- Expect small order size and frequent delivery.
- Harvest produce as close to time of delivery as possible to meet chefs' demand for premium quality.
- It's important to provide the chef with a weekly availability list.
- Chefs may require a consistent supply of particular items.



# Tips for Direct Sales to Restaurants

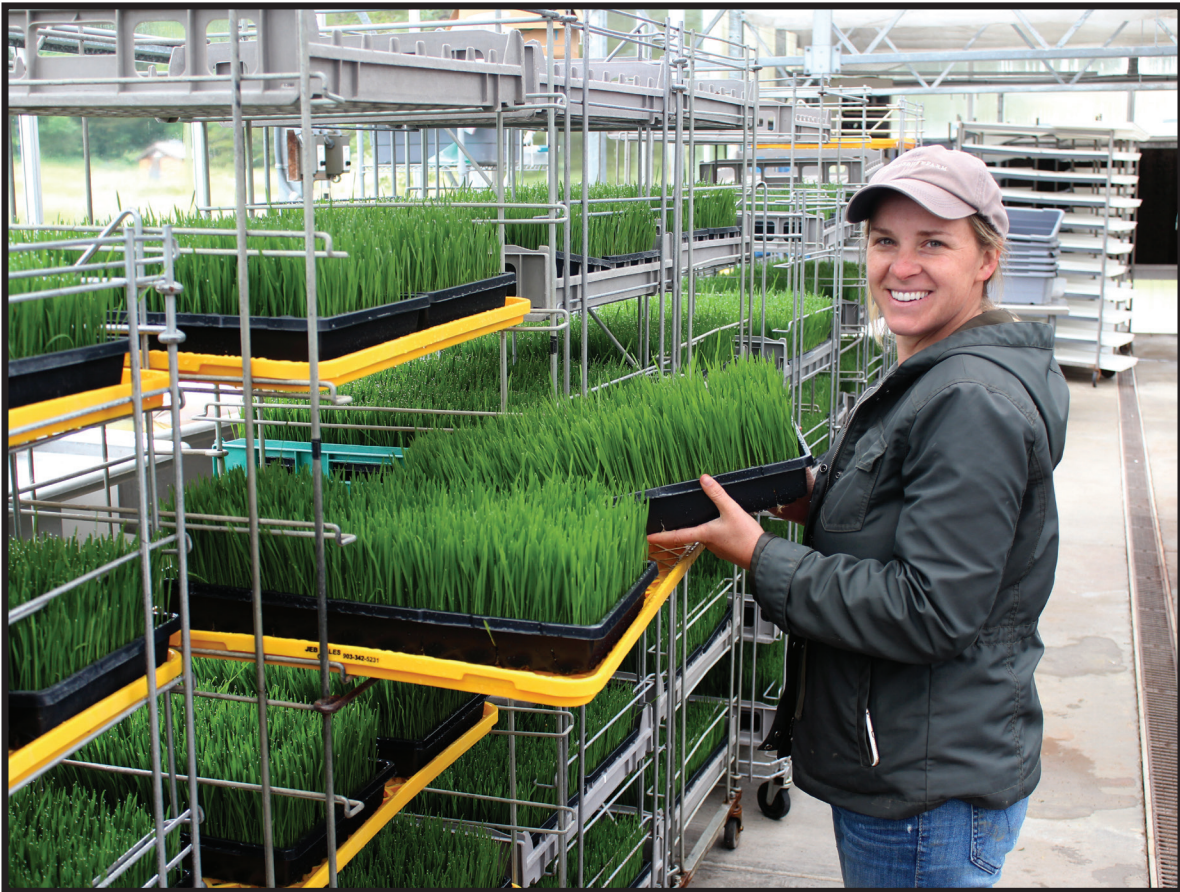
- Be consistent. Chefs expect a product will be delivered if they put it on the menu, and delivered when you say you will deliver it.
- Build a relationship with the entire staff. Chefs move frequently and may not take you with them. In order to keep the account, make sure you know other key players on the staff.
- Make calls and deliveries at convenient times for the restaurant and chefs. Chefs are on a tight schedule and generally require deliveries when they're not busy, such as before 10 a.m. or between 2 and 5 p.m.
- Introduce new products by dropping off free samples with your regular deliveries. Bring a brochure that lists what the item is, how it is packed and what it costs.
- Fax or email a weekly list of available products chefs can use to make orders. Some chefs prefer a text of your weekly product list. Find out how each chef wants to be contacted.
- Use the chefs as your best source of market trend information. They may know what the next big thing is before you do.
- Know how the chef is using your product and be prepared to talk about other ways to use it.
- In the autumn or winter, ask chefs what products they want you to grow next season. Take seed catalogs in and talk with each chef about what they would like for you to grow.
- Ask about each restaurant's needs: pack, size, variety, post-harvest preferences, new items, and how they would like to place orders (by fax, text message, phone, e-mail).
- Plant more than you think you need. An overabundance of product ensures the ability to harvest and deliver the best. If you have more than you need, you are able to grade out the produce and offer the best quality.
- Be professional. Be on time for delivery; call if you're running late. Be friendly, well groomed (no muddy boots in the kitchen!), and have invoices prepared ahead of time.





## Key Questions to Ask Yourself

- How far in advance do chefs need to see an accurate schedule of product availability in order to allow them to plan their menus?
- What restaurants are the best fit for my product profile? Ethnic? High end gourmet? Specialty bakeries?
- What production, handling, storage, and delivery methods will I use to ensure the freshest and highest quality products to high end chefs?
- How frequently and quickly am I able to deliver to restaurants? What are a chef's expectations about this?
- How do the restaurants want to communicate with me? Cell phone? Text message? Email? Fax?



# Advice For Farmers

## Questions Farmers Should Ask Chefs:

- What products do you need, in what quantity, and when?
- Would you be willing to promote my products in the restaurant or on the menu?
- Can I give you a few of my business cards or promotional materials to display?
- How will I, and when, should I expect payment?
- Who is the main point of contact? Are there additional contacts I should have on hand?
- What is the best way for us to communicate? Email? Phone? Fax? Text?
- What is the best time, and day, for me to deliver? Can you pick up?
- How would you like the products packaged?





## Important Reminders for Farmers

**Commitment and Consistency:** Deliver what you say you will deliver, when you say you will be there, with consistent quality.

**Communication:** Maintain an open dialog with your buyer. Tell them what's going on at the farm, what you're growing, what products have been popular with other customers, and what is working and what is not. Be sure to follow up on deliveries and find out what the customers liked best. Determine an agreed upon time every week to check in to find out what the restaurant needs and if they are satisfied.

**Schedule:** Find a regular delivery time that is efficient for you and the chef, which ensures they have a regular supply of fresh product and you have a scheduled sale. Know your customers' schedules and try to work around their busy times, like dinner and lunch rushes, or during other large deliveries. Timing is everything!

**Sell what you can deliver:** Don't "short the kitchen" – the chef is counting on a certain quantity. If your product changes, notify chefs immediately to see if they still want it. Keep past invoices and growing schedules for your records, then use them to reliably predict what you will be able to offer through the season. Plan to grow a little extra so you will have the ability to select the best produce.

**Know your customers and their customers:** Eat at the restaurants and find out how your product is used. Ask to see a menu, or sample seasonal menus if available. Determine ways to fit your products into their business. (Hint: Check online websites for menus!) These meals are a legitimate business expense, so keep receipts for your taxes!

**Maintain professionalism:** Be patient and diligent. Be punctual. Be courteous. Prepare invoices ahead of delivery, and call if you're running late. Don't deliver in dirty boots that will create mud in the kitchen.

**Invoicing and billing:** It's most efficient for everyone if you can establish an account and billing cycle. Have your invoices ready upon delivery.

**Specialize and diversify:** Your farm is unique and so is your story. Talk with chefs and find out what they need, or wish they could find, in particular. Some growers find it works best to concentrate on one or two strong crops; others find it's better to offer a variety and be able to cover most of a chef's produce needs for a week.

**Post harvest handling:** Wash your produce and have it packaged professionally in wax or cardboard boxes. Packaging should be designed to be easy to handle and not damaging to the product. (See insert: ATTRA'S "Postharvest Handling of Fruits and Vegetables" at <https://attra.ncat.org/attra-pub/viewhtml.php?id=378> ).



**NOTES:**

A series of horizontal lines for taking notes, spanning the width of the page below the 'NOTES:' header.



# Tips for Chefs and Restaurants



# Why Should Chefs Purchase From Local Producers?

## Advantages:

There are a variety of reasons to include locally grown items on your menu. Locally grown foods are the freshest, allowing you to cook with a higher quality product that has superior color, taste and texture compared to ingredients picked too early and shipped from far away. This translates into a better tasting, more attractive meal for your customers, and increased customer satisfaction. Going local allows you to expand your business by entering into a new niche market, bringing in new customers. According to the National Restaurant Association, local sourcing, environmental sustainability and healthful kids' meals keep gaining steam as the top trends on restaurant menus in 2015. Serving fresh picked local foods can increase the nutritional profile of your menu. Also, with the rise of the local food movement, customers are seeking out more than ever restaurants that serve locally grown goods.

## Why Choose to Use Local, Fresh, Ingredients:

- Customers can learn the background and stories for the farms that have ingredients on the menu. This allows the customer to have a connection to where their food is coming from.
- You are helping support the local community.
- Customers will enjoy knowing that their food was grown locally and identify the value of a superior product and fresh taste.

## Considerations:

- Consistent quantity and/or availability can sometimes be difficult.
- Relationship building with producers/farmers is key and varies from purchasing from traditional food service distributor operations.
- Menu planning requires knowing in advance what items are in season and meeting on occasion with producers to discuss long term plans for seasonal specialties, promotions, etc.
- Local sourcing can be more costly and requires close management of food waste.
- Direct payment to producers may vary from traditional distributor operation.

## Marketing Local Ingredients to Your Customers

Local food blogs, social media and events calendars can help you tell your story. Take the time to create a compelling and authentic message that will get you noticed. The mechanics of traditional and new online sources can allow you to map your strategies from an in-house and grassroots perspective. Present your relationship with your local producer in print, letting the consumer trace their food source to the farm.

By letting your customers know which products are locally grown, you advertise your support for local agriculture, thereby expanding your market potential. Also, it provides great advertising for the local farms which you source ingredients from, furthering the partnership between your businesses. Advertising the farms where products came from can serve as a valuable educational tool on knowing your local food system.

The Tennessee Department of Agriculture will provide advertising and promotional materials for restaurants that are members of Pick Tennessee Farm and Restaurant Alliance. Using the existing Pick Tennessee Products (PTP) brand on menus will allow diners to make a connection to their farming community. This Tennessee Department of Agriculture brand has earned the reputation for its high quality standards since 1986.

The Pick Tennessee Farm and Restaurant Alliance Directory, available on the Pick Tennessee Mobile App and at the [PickTNproducts.org](http://PickTNproducts.org) website informs the consumer on where to dine for locally sourced menu items and what farmers are selling to restaurants. Being a part of this Alliance will provide free advertising for your restaurant through a statewide media campaign. Diners will discover that menus and restaurant establishments exhibiting the Pick Tennessee Products brand carry the principles that cloak the local sourcing concept.



## Tips for Direct Purchases from Farmers

- Many producers will offer some sort of a delivery service for their produce to ensure a fresh taste upon fast delivery.
- Most producers do not have years of restaurant business experience, so details on delivery will need to be set up on the front end of the ordering.
- Encourage the entire staff to build a relationship with the producer so that he or she is comfortable to work with someone else in the restaurant if needed.
- Let the producer know ahead of season if there are certain products that you would like to see offered.
- Establish a consistent form of communication and order method. For example: Phone (business or mobile), Text messaging, Email, or Fax.
- Establish budget and managing food cost. It is important to run your numbers and look at how locally grown ingredients can fit into your business plan. When a large quantity of an in season ingredient is available, many choose to feature a “local” dish, which is available until it runs out. Some also choose to focus on just a few local items they can find in quantity, such as more commonly grown local produce items.





# Advice for Chefs

## Questions Chefs Should Ask Farmers:

- How long should we expect the growing season to last for this product, and how much is available?
- How would you like your product promoted at the restaurant or on the menu?
- What is the best way for us to send payment?
- Who is the main point of contact?
- What is the best way for us to communicate? Email? Phone? Fax? Text?
- What agricultural methods are used in production?
- What is the best time and day for you to deliver, and how far in advance do you need orders?
- If people ask about your product, can I give them your contact information?
- Do you have a flyer or other information I can handout? What food safety practices have you implemented?
- Do you have product liability insurance coverage for your produce? If so, how much?





# Topics to Discuss With Producers

- How long is growing season for each product, and how much is available?
- What new products might be available in the future, along with the existing products?
- If customers ask about the product, can contact information be given out?
- Is the produce covered by some sort of product liability insurance?
- If a certain product is not available from the producer, could recommendations be made as to where or who that product could be purchased from?
- What food safety practices are used to ensure that customers will be satisfied?



## Chefs' Checklist for Purchasing of Local Produce

Farm Name/ Farmer Name \_\_\_\_\_

Telephone \_\_\_\_\_ E mail \_\_\_\_\_

Available products \_\_\_\_\_

Liability insurance coverage \_\_\_\_\_

Production Practices	YES	NO	N/A
Are wells protected from contamination?			
If irrigation is used, what is its source? (circle)      Well      Municipal      Other _____			
Is the water tested for bacteria or other contaminants?			
Is soil use history available to determine risk of product contamination (e.g., runoff from upstream, flooding, chemical spills, or excessive agricultural crop application)?			
Are portable toilets used in a way that prevents field contamination from waste water?			

Product Handling	YES	NO	N/A
Are storage and packaging facilities located away from growing areas?			
Is there risk of contamination with manure?			
Are harvesting baskets, totes, or other containers kept covered and cleaned (with potable water) and sanitized before use?			
Are product and non-product containers available and clearly marked?			
Is dirt, mud, or other debris removed from product before packaging?			
Are food grade packaging materials clean and stored in areas protected from pets, livestock, wild animals, and other contaminants?			

Transportation	YES	NO	N/A
Is product loaded and stored to minimize physical damage and risk of contamination?			
Is transport vehicle well maintained and sanitized?			
Are there designated areas in transport vehicle for food products and non-food items?			
Are products kept cool during transit?			
Are products delivered within a reasonable length of time (No more than 48 hours post harvest)?			

Facilities	YES	NO	N/A
Is potable water/well tested at least once per year and results kept on file?			
Is product protected as it travels from field to packing facility?			
Is a product packing area in use with space for culling and storage?			

# Procurement

Are packing areas kept enclosed?			
Are food contact surfaces regularly washed and rinsed with potable water and then sanitized?			
Are food grade packaging materials used?			
Do workers have access to toilets and hand washing stations with proper supplies?			
Are toilets and hand washing stations clean and regularly serviced?			
Is a pest control program in place?			

<b>Worker (Student) Health and Hygiene</b>			
Is a worker food safety training program in place?			
Are workers trained about hygiene practices and sanitation with signs posted to reinforce messages?			
Are workers and visitors following good hygiene and sanitation practices?			
Are workers instructed not to work if they exhibit signs of infection (e.g., fever, diarrhea, sneezing, runny nose, etc.)?			
Do workers practice good hygiene by:			
wearing clean clothing and shoes?			
changing aprons and gloves as needed?			
keeping hair covered or restrained?			
washing hands as required?			
limiting bare hand contact with fresh products?			
covering open wounds with clean bandages?			

I confirm that the information provided above is accurate to the best of my knowledge.

Signature of seller: \_\_\_\_\_ Date: \_\_\_\_\_

Print name: \_\_\_\_\_ Phone Number: \_\_\_\_\_

Information for check list adapted from Iowa State University, University Extension, form PM2046a

# Important Reminders for Food Buyers

**Commitment and consistency:** Be a loyal customer. Buy what you say you will buy, and try to buy consistently while the product is in season. Setting up a steady routine with a farmer will allow them to plan their harvests and deliveries to optimize efficiency and quality--providing you with a better product.

**Communication:** Have an open conversation with the grower and describe to them how you plan to use their products. Establish a predictable routine for phone calls, orders, and questions. Give as much advance notice regarding your needs as you can. Always clarify the details, and if you're unhappy with a product or service, tell the growers why so they can work with you to suggest different products, change delivery times, etc.



**Buying:** Expect to pay a premium price for premium products. You can expect to learn why it's worth the price, and your customers will thank you with loyalty and word of mouth advertising!

**Flexibility:** Base your menu on what is in season and use what is fresh! If issues arise with your growers or your staff, try to understand the problem and find win-win solutions. It's all about the relationship! If you featured a great product this season and would like to do it again next year, tell your farmers so they can anticipate and meet that need next year.

**Delivery:** Establish a routine delivery schedule including day, time and point of contact. If conditions change at the restaurant, let the grower know immediately.

**Trust:** Remain open, transparent, flexible and patient. Remember, it's all about the relationship!

**Invoicing and billing:** Establish a payment system and follow through on your promises. Most farmers expect to be paid either COD or within 7 days of delivery.

**Education:** Share the growers' stories and continue to learn about products that are available. Inspire your staff and customers to do the same! Visit their farms during the summer or winter if you can, or stop by to see them at a farmers market if possible.



## Avenues to Find Locally Grown Ingredients

- Farmers markets are the best place to start, as you can meet local growers and see what crops are available each month during the growing season. From there you can arrange each week to purchase items for your seasonal menu.
- Create a relationship with growers and receive shipments each week to your restaurant. Collaborate with a grower and have specific crops grown for you for your desired menu items.
- Find out from your current food purveyor what local products they distribute and the farm they come from.
- Learn more about local food hubs in your area. A regional food hub is a business or organization that actively manages the aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail, and food service demand.



# Food Safety

Food safety is always a concern when serving food to the public. Safety is especially important when serving raw fruits and vegetables because there are no steps in the preparation process that kill contaminants that might have found their way into the food. That's why it is necessary to verify safety practices when purchasing from local growers.

The gold standard of food safety for handling fresh fruits and vegetables that will be sold to any consumer is Good Agricultural Practices (GAP) certification. GAP certification is a review from a third party auditor on how potential routes of contamination are addressed during planting, growing, harvesting, and post harvest periods. Although GAP certification is not required by the State of Tennessee Department of Agriculture or any regulatory agency in Tennessee, it demonstrates that the grower follows appropriate food safety practices on their farm.

The first step for growers wishing to adhere to GAPs is to conduct a risk assessment to evaluate their current farm practices. After a risk assessment is completed, growers should develop a food safety plan that describes what the practices are on their farm and documents their standard operating procedures (SOPs). These practices and farm policies should accurately reflect what the grower is currently doing in cultivating crops on their farm and describe operating procedures and accompanying records. As with any safety plan, documentation is required. Proper record keeping must be established and maintained.

In addition to the food safety plan, some buyers require liability insurance on products they plan to purchase. The amount of liability insurance should be determined by the buyer and communicated to all growers. Local insurance carriers can be a great resource for possible coverage.

Food safety does not end with the delivery of produce. You will need to continue to check and update your SOPs for receiving, storing, preparing and serving fresh fruits and vegetables. An excellent resource for SOPs can be found here: <http://sop.nfsmi.org>



# A Beginner's Guide to Local Source Menu Planning

## Menu Planning

The easiest way to incorporate locally sourced ingredients into your menu is to choose products that can easily be substituted into the current menus. Items that are available in the same form as those being currently purchased from conventional sources will be the least challenging to incorporate because there will not be a change in preparation. Products that require new recipes, additional preparation time, or supplies/equipment may be more challenging to incorporate into the program. Learning effective and efficient meal planning is a key step to enabling a strong local program.

## Menu Planning Tips

**Plan Ahead** - Before beginning your menu plan, look at what's in season by using websites, using a produce seasons chart accurate to your location, or making a note each time you're at the farmer's market. Find a routine that works for you. Having a locally grown menu is most successful when you are planning ahead.

**Save Time** – Taking time to establish good communications with your farmer will allow you to be well informed of what to expect and save you time in the delivery process and preparation of your locally grown menu items. Good communication will prepare you for the quantities that you will have to work with. If it is a seasonal item that is in abundance you will know that you can run specials or promote a certain menu entrées that can be readily available for your customer. Find a consistent day and time that works well with your staff's schedule to do the prep. Most meals have at least some, if not all, components that can be prepped ahead. The following can be helpful:

- chop vegetables
- make marinades & vinaigrettes
- cut melons and larger fruit
- toss vegetable or fruit salads (leaving dressing on the side)
- cook soups & stews

**Be Creative** – As your confidence grows so can your menu. Learn to create new products by creatively combining the seasonal items. When planning meals, don't forget about desserts! Desserts can become quite beautiful with seasonal fruits.



**NOTES:**

[illegible]





# Appendix



# Farm Measurements

Apples:	1 bushel	=	48 lb.
Cherries, sweet or sour:	1 bushel	=	48-50 lb.
Peaches:	1 bushel	=	48 lb.
Pears:	1 bushel	=	50 lb.
Plums:	1 bushel	=	56 lb.
Beans, snap, green or wax:	1 bushel	=	32 lb.
Corn, sweet, in husk:	1 bushel	=	35 lb.
Potatoes, Irish:	1 bushel	=	56 lb.
Potatoes, sweet:	1 bushel	=	50-55 lb.
Squash, summer:	1 bushel	=	40 lb.
Tomatoes:	1 bushel	=	53-56 lb.



# Kitchen Equivalents

This chart deciphers farm measures from those big bushels all the way to the tiniest teaspoon. You can feel confident that what you buy on the farm or at the farmers market will be the right amount for your recipes!

16 ounces	=	1 pound
4 pecks	=	1 bushel
8 quarts	=	1 peck
4 quarts	=	1 gallon
4 cups	=	1 quart
2 cups	=	1 pint
8 ounces	=	1 cup
4 ounces	=	1/2 cup
5 tablespoons + 1 teaspoon	=	1/3 cup
16 tablespoons	=	1 cup
4 tablespoons	=	1/4 cup
2 tablespoons	=	1/8 cup
3 teaspoons	=	1 tablespoon
A pinch	=	1/8 tsp. or less





# Tennessee Seasonality Chart

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
APPLES												
ASPARAGUS												
BOK CHOY												
BEETS												
BELL PEPPERS												
Blackberries(summer bearing)												
Blackberries(primocane bearing)												
Blueberries(highbush varieties)												
Blueberries(rabbiteye varieties)												
Boysenberries												
Broccoli												
Cabbage												
Cantaloupes												
Cauliflower												
Chinese Cabbage												
Cherries												
Carrots												
Cherry Tomatoes												
Collard Greens												
Cucumbers												
Eggplant												
English Peas												
Field Peas												
Garlic												
Gooseberries												
Grapes												
Greens												
Herbs												
Honeydew												
Hot Peppers												
Kale												
Leeks												
Lettuce												
Lima Beans												
Melons, Specialty												
Muscadine Grapes												
Mushrooms												
Mustard Greens												
Nectarines												
October Beans												
Okra												
Onions												
Peaches												
Pears												
Pimiento Peppers												

# Tennessee Seasonality Chart *continued...*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Plums												
Polebeans												
Popcorn												
Potatoes												
Pumpkins												
Raspberries(summer bearing)												
Raspberries(fall bearing)												
Rhubarb												
Shelly Beans												
Snapbeans												
Snow Peas												
Spinach												
Sugar Peas												
Sweet Potatoes												
Squash(summer varieties)												
Squash(winter varieties)												
Strawberries												
Sweet Corn												
Tomatoes												
Turnips												
Watermelons												
Wax Beans												



## Farming Terms

**CERTIFIED NATURALLY GROWN (CNG)** Products certified by an independent nonprofit organization (not USDA) as having been produced in approximate accordance with national organic standards. The program requires less paperwork and lower certification fees for farmers than the USDA's National Organic Program.

**CONVENTIONAL** Standard agricultural practices widespread in the industry. May (but does not necessarily) include use of pesticides, synthetic fertilizers, "monocropping," antibiotics, hormones and other chemical approaches. In the US, may also include use of Genetically Modified Organisms (GMOs).

**DRY-FARMED** Produce grown using a tilling technique that seeks to retain soil moisture and to minimize or eliminate the use of irrigation.


**FARM FRESH** This phrase is a marketing term used in retail and direct farm sales. In general it means that the product is being purchased directly from a farm. If freshness is a concern, ask when the produce was harvested or the eggs collected.

**GENETICALLY MODIFIED ORGANISMS (GMOs)** Plants and animals whose genetic make-up has been altered to exhibit traits not normally present, such as longer shelf-life, different color, or resistance to certain chemicals. In general, genes are taken (copied) from an organism with a desired trait and transferred into the genetic code of another organism.

**HEIRLOOM** (also called farmers' or traditional varieties) Developed by farmers through years of cultivation, selection, and seed saving, then passed down through generations (generally regarded as having been in existence for a minimum of 50 years).

**INTEGRATED PEST MANAGEMENT (IPM)** Strategies aiming to reduce the use of chemical pesticides through careful monitoring for actual pest threats. Pesticides are applied in ways to pose the least possible hazard, and are used as a last resort when other controls are found inadequate.

**LOCALLY GROWN** Food and other agricultural products produced, processed, and sold within a certain region, whether defined by distance, state border, or regional boundaries. The term is not nationally regulated, meaning individual farmers markets can define and regulate the term based on their own mission and circumstances.



**NATURALLY GROWN/ALL NATURAL USDA** guidelines state that “natural” meat and poultry products can only undergo minimal processing and cannot contain artificial colors, artificial flavors, preservatives, or other artificial ingredients. The claim “natural” is otherwise unregulated.

**NO SPRAY/PESTICIDE-FREE** No pesticides, herbicides, or fungicides have been applied to the crop at any point in production, even though the produce is not organically grown.

**NO-TILL** A method of reducing soil erosion by planting crops without tilling the soil. Herbicides may be relied upon to control weeds.

**ORGANICALLY GROWN/CERTIFIED ORGANIC** All products sold as ‘organic’ must meet the USDA National Organic Program standards. Certification is mandatory for farmers selling more than \$5,000 of organic products per year, and includes annual submission of an organic system plan and inspection of farm fields and processing facilities to verify that organic practices and record keeping are being followed.

**SUSTAINABLE AGRICULTURE** Farming practices? that is are? socially just, humane, economically viable, and environmentally sound. The term is unregulated.

**TRANSITIONAL** Farmers must practice organic methods for three years on a given piece of land before the products harvested from that land can be sold or labeled as organic. “Transitional” is an unofficial term referring to farmland that is in the midst of that 3-year period towards organic certification.

**VINE-RIPENED/TREE-RIPENED** Fruit that has been allowed to ripen on the vine or tree. Many fruits that are shipped long distances are picked while still unripe and firm, and later treated with ethylene gas at the point of distribution to “ripen” and soften them.



# Food Processing Terms

**ARTISAN/ARTISANAL** Implying that products are made by hand in small batches. Ingredients can come from any source, and are not necessarily connected with the farm or producer.

**GAP (Good Agricultural Practices)** Voluntary recommended principles for on-farm production, post-harvest processing, and storage of food that reduce risks of microbial contamination.

**RAW FOODS** (including milk, cheeses, cider, vinegar, sauerkraut, and almonds) not pasteurized (heated) to a minimum of 145° F. In the U.S., raw milk cheeses are required to be aged for 60 days. In some states, including TN, sales of raw milk is prohibited.

**SECONDS** Produce that is bruised, blemished, overripe, misshapen, or otherwise deemed unfit for regular sale. Seconds, for cooking or canning, are often available in large quantities and at lower prices.

**SULFURED/UNSULFURED** Many dried fruits are treated with sulfur dioxide (SO<sub>2</sub>) or meta bisulfate to keep them from oxidizing during and after the drying process. This preserves their original color and acts as a preservative. Unsulfured fruits are often dark brown in color.

**USDA** United States Department of Agriculture; this agency forms policy and procedures for food production and processing at the national (federal) level, regulates interstate commerce of agricultural products, promotes markets for U.S. agricultural products domestically and abroad, implements various food assistance and education programs, and manages on farm natural resource conservation programs.

**USDA INSPECTED FACILITY** A meat, poultry, or egg processing facility under inspection by the USDA Food Safety Inspection Service (FSIS). Such inspections are mandatory for meat and poultry products intended for interstate and foreign commerce; FSIS also monitors state inspection programs for meat products sold only within the state in which they were produced. Meat sold retail at markets as individual cuts requires the USDA stamp of inspection.

**VEGAN** Foods containing no animal product, meaning that they exclude meat, dairy, eggs, gelatin, or honey.

**WOOD-FIRED OVEN BREAD** Breads baked in an oven made of brick, clay, or sod that is heated by burning wood.

Sourced information from the **Farmers Market Coalition Glossary of Terms**.

# Sample Standard Operating Procedures (SOPs)

## WASHING FRUITS AND VEGETABLES (Sample SOP)

This Sample SOP explains how to prevent or reduce risk of foodborne illness or injury by contaminated fruits and vegetables. This procedure applies to foodservice employees who prepare or serve food.

### INSTRUCTIONS:

1. Train foodservice employees on using the procedures in this SOP.
2. Follow state or local health department requirements.
3. Wash hands using the proper procedure.
4. Wash, rinse, sanitize, and air-dry all food-contact surfaces, equipment, and utensils that will be in contact with produce, such as cutting boards, knives, and sinks.
5. Follow manufacturer's instructions for proper use of chemicals.
6. Wash all raw fruits and vegetables thoroughly before combining with other ingredients, including:
  - Unpeeled fresh fruit and vegetables that are served whole or cut into pieces.
  - Fruits and vegetables that are peeled and cut to use in cooking or served ready-to-eat.
7. Wash fresh produce vigorously under cold running water or by using chemicals that comply with the 2001 FDA Food Code. Packaged fruits and vegetables labeled as being previously washed and ready-to-eat are not required to be washed.
8. Scrub the surface of firm fruits or vegetables such as apples or potatoes using a clean and sanitized brush designated for this purpose.
9. Remove any damaged or bruised areas.
10. Label, date, and refrigerate fresh-cut items.
11. Serve cut melons within 7 days if held at 41 °F or below. Refer to the Date Marking

Ready-to-Eat, Potentially Hazardous Food SOP. 12. Do not serve raw seed sprouts to highly susceptible populations such as pre-school-age children.

### MONITORING:

1. The foodservice manager will visually monitor that fruits and vegetables are being properly washed, labeled, and dated during all hours of operation.
2. Foodservice employees will check daily the quality of fruits and vegetables in cold storage.

### CORRECTIVE ACTION:

1. Retrain any foodservice employee found not following the procedures in this SOP.
2. Remove unwashed fruits and vegetables service and washed immediately before being served.
3. Label and date fresh cut fruits and vegetables.
4. Discard cut melons held after 7 days.

### VERIFICATION AND RECORD KEEPING:

Retrain any foodservice employee found not following the procedures in this SOP. Remove unwashed fruits and vegetables service and washed immediately before being served. Label and date fresh cut fruits and vegetables.

Date Implemented: \_\_\_\_\_ By: \_\_\_\_\_

Date Reviewed: \_\_\_\_\_ By: \_\_\_\_\_

Date Revised: \_\_\_\_\_ By: \_\_\_\_\_



# POSTHARVEST HANDLING OF FRUITS AND VEGETABLES

HORTICULTURE TECHNICAL NOTE

ATTRA is the national sustainable agriculture information center funded by the USDA's Rural Business -- Cooperative Service.

**Abstract:** *Appropriate production practices, careful harvesting, and proper packaging, storage, and transport all contribute to good produce quality. This publication covers postharvest practices suitable for small-scale operations, and points out the importance of production and harvesting techniques for improving quality and storability. Various methods for cooling fresh produce are discussed, and resources are listed for further information, equipment, and supplies.*

**By Janet Bachmann and Richard Earles**  
**NCAT Agriculture Specialists**  
**August 2000**

## Introduction

You have spent months working in the fields, and now have a bountiful harvest of beautiful fruits and vegetables. You want to ensure that your customers will also enjoy this healthy harvest. How can you best maintain the quality and safety of your produce as it travels from the field to the table? How can produce be stored so that it does not need to be sold immediately? High-quality, disease-free produce with a good shelf life is a result of sound production practices, proper handling during harvest, and appropriate postharvest handling and storage.



and have a longer shelf life than others. In addition, environmental factors such as soil type,

temperature, frost, and rainy weather at harvest can have an adverse effect on storage life and quality.

For example, carrots grown on muck soils do not hold up as well in storage as carrots grown on lighter, upland soils. Lettuce harvested during a period of rain does not ship well and product losses are increased (1).

Management practices can also affect postharvest quality. Produce that has been stressed by too much or too little water, high rates of nitrogen, or mechanical injury (scrapes, bruises, abrasions) is particularly susceptible to postharvest diseases. Mold and decay on winter squash, caused by the fungus *Rhizoctonia*, result from the fruits lying on the ground, and can be

alleviated by using mulch. Broccoli heads are susceptible to postharvest rot caused by the bacteria *Erwinia* if nitrogen is applied as foliar feed—a grower should feed the soil, not the leaves. Beets and radishes are susceptible to soil-borne diseases when the soil

## Production Practices

Production practices have a tremendous effect on the quality of fruits and vegetables at harvest and on postharvest quality and shelf life. To start with, it is well known that some cultivars ship better

### Contents:

Production Practices.....	1
Harvest Handling.....	2
Postharvest & Storage .....	2
References .....	8
Enclosures .....	9
Resources.....	9
Appendix I: Storage Conditions .....	13
Appendix II: The Portacooler.....	15

temperature reaches 80° F; symptoms are black spots on these root crops (2).

Food safety also begins in the field, and should be of special concern, since a number of outbreaks of foodborne illnesses have been traced to contamination of produce in the field. Common-sense prevention measures include a number of *don'ts* (3):

- Don't apply raw dairy or chicken manure or slurries to a field where a vegetable crop such as leafy lettuce is growing.
- Don't apply manure to an area immediately adjacent to a field nearing harvest maturity.
- Don't forget to clean equipment that has been used to apply manure to one field before moving it to another field in production.
- Don't irrigate with water from a farm pond used by livestock.
- Don't harvest fruit from the orchard floor for human consumption as whole fruit or nonpasteurized juices, especially if manure has been spread or animals allowed to graze.
- Don't accumulate harvested product in areas where birds roost.

A grower *should* constantly evaluate water used for irrigation, and compost all animal manures before applying them to fields. There are many good sources of information on growing conditions and production practices that promote postharvest quality. Consult textbooks, Extension publications, and trade journals, and become involved with grower organizations to find out more.

## Harvest Handling

Quality cannot be improved after harvest, only maintained; therefore it is important to harvest fruits, vegetables, and flowers at the proper stage and size and at peak quality. Immature or overmature produce may not last as long in storage as that picked at proper maturity (4). Cooperative Extension Service publications are an excellent source of information on harvest maturity indicators for vegetables and fruits.

Harvest should be completed during the coolest time of the day, which is usually in the early morning, and produce should be kept shaded in the field. Handle produce gently. Crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay, and other deterioration. Bruises and other mechanical damage not only affect appearance, but provide entrance to decay organisms as well.

Postharvest rots are more prevalent in fruits and vegetables that are bruised or otherwise damaged. Mechanical damage also increases moisture loss. The rate of moisture loss may be increased by as much as 400% by a single bad bruise on an apple, and skinned potatoes may lose three to four times as much weight as non-skinned potatoes. Damage can be prevented by training harvest labor to handle the crop gently; harvesting at proper maturity; harvesting dry whenever possible; handling each fruit or vegetable no more than necessary (field pack if possible); installing padding inside bulk bins; and avoiding over or under-packing of containers (4).

## Postharvest and Storage Considerations

### Packaging

Packaging should be designed to prevent physical damage to produce, and be easy to handle. The *American Vegetable Grower* magazine's annual product guide is a good source of information about suppliers (see **Resources**).

### Temperature

Temperature is the single most important factor in maintaining quality after harvest. Refrigerated storage retards the following elements of deterioration in perishable crops:

- aging due to ripening, softening, and textural and color changes;
- undesirable metabolic changes and respiratory heat production;
- moisture loss and the wilting that results;
- spoilage due to invasion by bacteria, fungi, and yeasts;
- undesirable growth, such as sprouting of potatoes (5).



One of the most important functions of refrigeration is to control the crop's respiration rate. Respiration generates heat as sugars, fats, and proteins in the cells of the crop are oxidized. The loss of these stored food reserves through respiration means decreased food value, loss of flavor, loss of salable weight, and more rapid deterioration. The respiration rate of a product strongly determines its transit and postharvest life. The higher the storage temperature, the higher the respiration rate will be (4).

For refrigeration to be effective in postponing deterioration, it is important that the temperature in cold storage rooms be kept as constant as possible. Appendix I charts the optimum temperature ranges for various crops. Exposure to alternating cold and warm temperatures may result in moisture accumulation on the surface of produce (sweating), which may hasten decay. Storage rooms should be well insulated and adequately refrigerated, and should allow for air circulation to prevent temperature variation. Be sure that thermometers, thermostats, and manual temperature controls are of high quality, and check them periodically for accuracy (5).

On-farm cooling facilities are a valuable asset for any produce operation. A grower who can cool and store produce has greater market flexibility because the need to market immediately after harvest is eliminated. The challenge, especially for small-scale producers, is the set-up cost. Innovative farmers and researchers have created a number of designs for low-cost structures. Some of these ideas are detailed in Appendix II and in the enclosures attached to this document. Additional designs are available in publications listed in the **Resources** section.

### *Pre-cooling*

Pre-cooling is the first step in good temperature management. The *field heat* of a freshly harvested crop – heat the product holds from the sun and ambient temperature – is usually high, and should be removed as quickly as possible before shipping, processing, or storage. Refrigerated trucks are not designed to cool fresh commodities but only maintain the temperature of pre-cooled

produce. Likewise, most refrigerated storage rooms have neither the refrigeration capacity nor the air movement needed for rapid cooling. Therefore, pre-cooling is generally a separate operation requiring special equipment and/or rooms (4, 5).

Rapid pre-cooling to the product's lowest safe temperature is most critical for crops with inherently high respiration rates. These include artichokes, brussels sprouts, cut flowers, green onions, snap beans, asparagus, broccoli, mushrooms, peas, and sweet corn. Crops with low respiration rates include nuts, apples, grapes, garlic, onions, potatoes (mature), and sweet potatoes (4).

Appropriate pre-cooling methods as well as appropriate storage temperature and humidity for a number of fruits and vegetables are shown in Appendix I. The following methods are the most commonly used:

- **Room cooling:** Produce is placed in an insulated room equipped with refrigeration units. This method can be used with most commodities, but is slow compared with other options. A room used only to *store* previously cooled produce requires a relatively small refrigeration unit. However, if it is used to *cool* produce, a larger unit is needed. Containers should be stacked so that cold air can move around them, and constructed so that it can move through them. Used refrigerated truck bodies make excellent small cooling rooms (4).
- **Forced-air cooling:** Fans are used in conjunction with a cooling room to pull cool air through packages of produce. Although the cooling rate depends on the air temperature and the rate of air flow, this method is usually 75–90% faster than room cooling. Fans should be equipped with a thermostat that automatically shuts them off as soon as the desired product temperature is reached.

**To avoid over-cooling and dehydration of produce, do not operate forced-air fans after the produce has been cooled to its optimum temperature (4).**



- **Hydro-cooling:** Dumping produce into cold water, or running cold water over produce, is an efficient way to remove heat, and can serve as a means of cleaning at the same time. In addition, hydro-cooling reduces water loss and wilting. Use of a disinfectant in the water is recommended to reduce the spread of diseases. Hydro-cooling is not appropriate for berries, potatoes to be stored, sweet potatoes, bulb onions, garlic, or other commodities that cannot tolerate wetting.

Water removes heat about five times faster than air, but is less energy-efficient. Well water is a good option, as it usually comes out of the ground with temperatures in the 50–60° F range. Mechanical refrigeration is the most efficient method for cooling water. A thermal storage immersion hydro-cooler system can be fabricated economically to suit various volume requirements. Used stainless-steel bulk farm milk coolers may be an option. If hydro-cooling water is recirculated, it should be chlorinated to minimize disease problems (4).

A study compared sweet corn quality after hydro-cooling with ice water, well water cooling, and refrigerated air cooling, and subsequent refrigerated storage. Hydro-cooling with ice water lowered the temperature of the ears most quickly. Well

water cooling followed by refrigerated storage appeared to offer no advantage over refrigerated storage immediately after harvest (6).

- **Top or liquid icing:** Icing is particularly effective on dense products and palletized packages that are difficult to cool with forced air. In top icing, crushed ice is added to the container over the top of the produce by hand or machine. For liquid icing, a slurry of water and ice is injected into produce packages through vents or handholds without removing the packages from pallets and opening their tops. Icing methods work well with high-respiration commodities such as sweet corn and broccoli. One pound of ice will cool about three pounds of produce from 85° F to 40° F (7, 8).
- **Vacuum cooling:** Produce is enclosed in a chamber in which a vacuum is created. As the vacuum pressure increases, water within the plant evaporates and removes heat from the tissues. This system works best for leafy crops, such as lettuce, which have a high surface-to-volume ratio. To reduce water loss, water is sometimes sprayed on the produce prior to placing it in the chamber. This process is called *hydrovac* cooling. The primary drawback to this method is the cost of the vacuum chamber system (9).

### These products can be iced:

Artichokes  
Asparagus  
Beets  
Broccoli  
Cantaloupes  
Carrots  
Cauliflower  
Endive  
Green onions  
Leafy greens  
Radishes  
Spinach  
Sweet corn  
Watermelon



## These items are damaged by direct contact with ice:

Strawberries  
Blueberries  
Raspberries  
Tomatoes  
Squash  
Green beans  
Cucumbers  
Garlic  
Okra  
Bulb onions  
Romaine lettuce  
Herbs



### Chilling injury

Many vegetables and fruits store best at temperatures just above freezing, while others are injured by low temperatures and will store best at 45 to 55 degrees F. Both time and temperature are involved in chilling injury. Damage may occur in a short time if temperatures are considerably below the danger threshold, but some crops can withstand temperatures a few degrees into the danger zone for a longer time. The effects of chilling injury are cumulative in some crops. Low temperatures in transit, or even in the field shortly before harvest, add to the total effects of chilling that might occur in storage (7).

Crops such as basil, cucumbers, eggplants, pumpkins, summer squash, okra, and sweet potatoes are highly sensitive to chilling injury. Moderately sensitive crops are snap beans, muskmelons, peppers, winter squash, tomatoes,

and watermelons (8). These crops may look sound when removed from low temperature storage, but after a few days of warmer temperatures, chilling symptoms become evident: pitting or other skin blemishes, internal discoloration, or failure to ripen. Tomatoes, squash, and peppers that have been over-chilled may be particularly susceptible to decay such as *Alternaria* rot (7).

### Preventing moisture loss

While temperature is the primary concern in the storage of fruits and vegetables, relative humidity

is also important. The relative humidity of the storage unit directly influences water loss in produce. Water loss can severely degrade quality—for instance, wilted greens may require excessive trimming, and grapes may shatter loose from clusters if their stems dry out. Water loss means salable weight loss and reduced profit (4).

Most fruit and vegetable crops retain better quality at high relative humidity (80 to 95%), but at this humidity, disease growth is encouraged. The cool temperatures in storage rooms help to reduce disease growth, but sanitation and other preventative methods are also required. Maintaining high relative humidity in storage is complicated by the fact that refrigeration removes moisture. Humidification devices such as spinning disc aspirators may be used. Even buckets of water will increase humidity as the fans blow air across the water's surface and increase evaporation (10). Keeping the floor wet is helpful, though messy and potentially hazardous to two-legged creatures; frequent cleansing with a weak chlorine solution will be needed to prevent harboring of disease organisms in water and produce scraps on the floor. Crops that can tolerate direct contact with water may be sprinkled to promote high relative humidity (4).

When it comes to maintaining appropriate humidity levels, "the biggest thing for small growers is going to be monitoring equipment," says Kansas State University Extension Specialist Karen Gast. Humidity is measured by an instrument called a hygrometer. Several companies offer small, low-priced hygrometers

suitable for small-scale producers (10). See **Resources** for more information.

### Sanitation

Sanitation is of great concern to produce handlers, not only to protect produce against postharvest diseases, but also to protect consumers from foodborne illnesses. *E. coli* 0157:H7, *Salmonella*, *Chryptosporidium*, *Hepatitis*, and *Cyclospora* are among the disease-causing organisms that have been transferred via fresh fruits and vegetables (3, 11). Use of a disinfectant in wash water can help to prevent both postharvest diseases and foodborne illnesses.

Chlorine in the form of a sodium hypochlorite solution (for example, Clorox™) or as a dry, powdered calcium hypochlorite can be used in hydro-cooling or wash water as a disinfectant. Some pathogens such as *Chryptosporidium*,

however, are very resistant to chlorine, and even sensitive ones such as *Salmonella* and *E. coli* may be located in inaccessible sites on the plant surface. For the majority of vegetables, chlorine in wash water should be

maintained in the range of 75–150 ppm (parts per million.) The antimicrobial form, hypochlorous acid, is most available in water with a neutral pH (6.5 to 7.5).

The effectiveness of chlorine concentrations are reduced by temperature, light, and interaction with soil and organic debris. The wash water should be tested periodically with a monitoring kit, indicator strips, or a swimming pool-type indicator kit. Concentrations above 200 ppm can injure some vegetables (such as leafy greens and celery) or leave undesirable off-flavors.

Organic growers must use chlorine with caution, as it is classified as a restricted material. The California Certified Organic Farmers regulations permit a maximum of 4 ppm residual chlorine, measured downstream of the product wash (3). Growers certified by other agencies should check with their certifying agent.

Ozonation is another technology that can be used to sanitize produce. A naturally occurring molecule, ozone is a powerful disinfectant. Ozone has long been used to sanitize drinking water, swimming pools, and industrial wastewater. Fruit and vegetable growers have begun using it in dump tanks as well, where it can be thousands of times more effective than chlorine. Ozone not only kills whatever foodborne pathogens might be present, it also destroys microbes responsible for spoilage. A basic system consists of an ozone generator, a monitor to gauge and adjust the levels of ozone

Amounts of hypochlorite to add to clear, clean water for disinfestation.			
	target ppm	ounces/5 gallons	cup/50 gallons
<b>Sodium hypochlorite</b>	50	.55	.5
<b>(5.25%)</b>	75	.8	.75
	100	1.1	1.0
	125	1.4	1.25
	150	1.7	1.5
<b>Sodium hypochlorite</b>	50	.12	.1
<b>(12.7%)</b>	75	.17	.15
	100	.23	.2
	125	.29	.25
	150	.35	.3

being produced, and a device to dissolve the ozone gas into the water. Systems cost anywhere from \$10,000 to \$100,000, and should be installed by an ozone sanitation company experienced in produce industry applications (12).

Hydrogen peroxide can also be used as a disinfectant. Concentrations of 0.5% or less are effective for inhibiting development of postharvest decay caused by a number of fungi. Hydrogen peroxide has a low toxicity rating and is generally recognized as having little potential for environmental damage. The ATTRA

publication *Sources for Organic Fertilizers and Amendments* lists several sources of food-grade hydrogen peroxide.

Creative growers can customize their produce-washing system to promote sanitation and increase efficiency and ease of operation. At Drumlin Community Farm in Madison, Wisconsin, the crew “used to wash greens and small crops by the handfuls in wash tubs and air dry them on screen tables. Now they line harvest containers with a mesh produce bag, dunk the whole bagful at once, and dry two bagfuls at a time in an old washing machine set to spin cycle.” At another farm, loose greens are dumped into a 500-gallon bulk milk tank. The water in the tank is agitated with bubbling air from a jacuzzi motor. The washed greens are scooped out of the tank with a mesh bag-lined laundry basket, and the bags of greens are then spun dry in a washing machine. The grower removed the washer’s agitator to make more room for the produce (13).

This type of system has several advantages – it reduces handling (and potential damage) of the crop; it makes the washing process more time and labor efficient; and it enhances postharvest quality by getting the crop cooled down, washed, dried, and in cold storage much more quickly. Perhaps most importantly, washing greens in large batches rather than one-by-one reduces physical stress on the worker’s back and arms.

At a cost of \$2–8 each, woven polyester or nylon bags are durable, lightweight, water-permeable, and fast-drying. Suitable mesh laundry bags may be found at hardware or discount stores (13). The **Resources** section lists two companies that sell mesh bags by mail order. Spin-drying can be done with a washing machine, honey extractor, or commercial salad spinner. A restaurant or industrial-scale salad spinner is an efficient machine for both washing and drying greens (available from restaurant supply stores; prices range from \$650 to \$1500).

Some further tips for postharvest handling of lettuce and other leafy greens: package in breathable or perforated plastic bags; refrigerate

at 33° F; carry to market in a portable cooler, either refrigerated or with ice, and keep in the cooler until ready to display. If displaying unwrapped heads at a farmers’ market, mist occasionally with cold water.

### *Ethylene*

Ethylene, a natural hormone produced by some fruits as they ripen, promotes additional ripening of produce exposed to it. The old adage that one bad apple spoils the whole bushel is true. Damaged or diseased apples produce high levels of ethylene and stimulate the other apples to ripen too quickly. As the fruits ripen, they become more susceptible to diseases.

Ethylene “producers” should not be stored with fruits, vegetables, or flowers that are sensitive to it. The result could be loss of quality, reduced shelf life, and specific symptoms of injury. Some examples of ethylene effects include:

- russet spotting of lettuce along the midrib of the leaves;
- loss of green color in snap beans;
- increased toughness in turnips and asparagus spears;
- bitterness in carrots and parsnips;
- yellowing and abscission of leaves in broccoli, cabbage, Chinese cabbage, and cauliflower;
- accelerated softening of cucumbers, acorn and summer squash;
- softening and development of off-flavor in watermelons;
- browning and discoloration in eggplant pulp and seed;
- discoloration and off-flavor in sweet potatoes;
- sprouting of potatoes;
- increased ripening and softening of mature green tomatoes (8); and
- shattering of raspberries and blackberries (2).

Ethylene producers include apples, apricots, avocados, ripening bananas, cantaloupes, honeydew melons, ripe kiwifruit, nectarines, papayas, passionfruit, peaches, pears, persimmons, plantains, plums, prunes, quinces, and tomatoes (14). Produce that is sensitive to ethylene is indicated in Appendix I.



## Mixed loads

When different commodities are stored or transported together, it is important to combine only those products that are compatible with respect to their requirements for temperature, relative humidity, atmosphere (oxygen and carbon dioxide), protection from odors, and protection from ethylene (4).

In regard to cross-transfer of odors, combinations that should be avoided in storage rooms include: apples or pears with celery, cabbage, carrots, potatoes, or onions; celery with onions or carrots; and citrus with any of the strongly scented vegetables. Odors from apples and citrus are readily absorbed by meat, eggs, and dairy products. Pears and apples acquire an unpleasant, earthy taste and odor when stored with potatoes. It is recommended that onions, nuts, citrus, and potatoes each be stored separately (4).

## Storage crops

What about the crops that will not be transported and marketed fresh after harvest? Growers can extend their selling season into the winter months by growing root crops and other vegetables and fruits suited for long-term storage. The challenge is in keeping quality high by creating and maintaining the correct storage environment. As *Growing for Market* editor Lynn Byczynski notes,

Most storage crops require low temperatures and high humidity, two factors that don't come together easily. Several others require low humidity and low temperatures. And then there are a few that fall in between...Root crops such as beets, carrots, turnips, rutabagas, and leeks store best at 32° F and 90% humidity. Potatoes prefer temperatures of 40–60° F and 90% humidity. Onions and garlic like it cool – 32° – but require less humidity – about 65–75%. Winter squash prefer temperatures of 50–60° F, but dry. That's four different types of storage for vegetables that will hold a month or more: cold and humid; cold and dry; cool and humid; cool and dry (10).

The two structural options for storage of these crops are coolers and root cellars. Byczynski provides an example of a farm using both: "The Seelys have a bank barn, which has the bottom floor built into a hillside...They have built both coolers and a dry storage room into the lower floor to provide different combinations of temperature and humidity for the vegetables they store." Coolers used for root crop storage will require water added to the air and regular monitoring of the humidity level (see discussion under *Preventing moisture loss* above.) Some growers have used concrete basements of houses, closed off from heat and with ventilation to let in cold winter air, as root cellars. Another idea is to bury a big piece of culvert under a hillside (10).

Whatever the method, only "perfect" produce is suitable for long-term storage, so careful inspection is critical. Any damaged produce is going to spoil and induce spoilage in the rest of the crop. Byczynski advises growers to "either rub off soil and leave the crops somewhat dirty, or wash them and let them dry thoroughly before putting them in storage. With onions, garlic, winter squash, pumpkins and sweet potatoes, it's important that they be cured thoroughly before storage" (10).

## Conclusion

Postharvest handling is the final stage in the process of producing high quality fresh produce. Being able to maintain a level of freshness from the field to the dinner table presents many challenges. A grower who can meet these challenges, will be able to expand his or her marketing opportunities and be better able to compete in the marketplace. This document is intended to serve as an introduction to the topic and a resource pointer; the grower is advised to seek out more complete information from Extension and other sources.

## References:

- 1) Herner, Robert C. 1989. Sources of loss cited during post harvest handling. Great Lakes Vegetable Growers News. May. p. 16.



- 2) Andersen, Craig. 1998. Postharvest handling workshop. Huntsville, AR. February 22.
- 3) Suslow, Trevor. 1997. Microbial food safety: an emerging challenge for small-scale growers. *Small Farm News*. June-July. p. 7-10.
- 4) Wilson, L.G., M.D. Boyette, and E.A. Estes. 1995. Postharvest Handling and Cooling of Fresh Fruits, Vegetables and Flowers for Small Farms. Leaflets 800-804. North Carolina Cooperative Extension Service. 17 p. Accessed on-line at: <http://www.foodsafety.org/nc/nc1055.htm>
- 5) Hardenburg, Robert, et al. 1986. The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. USDA Handbook No. 66. United States Department of Agriculture, Agricultural Research Service. 136 p.
- 6) Wilhelm, Luther R. et al. 1992. Effect of cooling treatment on the quality of sweet corn. *Tennessee Farm and Home Science*. Winter. p. 30-35.
- 7) Anon. 1992. Put it on ice. *American Vegetable Grower*. June. p. 17-18.
- 8) Howell, John C., editor. 1993. Postharvest handling. *Vegetable Notes: Growing and Marketing Information for Massachusetts Commercial Growers*. p. 1-5
- 9) Sasseville, David N. 1988. Harvesting and handling produce: Plan now for high quality. *Missouri Farm*. May-June. p. 19-21.
- 10) Byczynski, Lynn. 1997. Storage crops extend the season. *Growing for Market*. September. p. 1, 4-5.
- 11) Melnick, Rick. 1998. Safety sets the table. *American Vegetable Grower*. February. p. 9-11, 13, 15.
- 12) Gooch, Jamie. 1998. Getting into the 'o' zone. *Fruit Grower*. January. p. 10-11.
- 13) Newenhouse, Astrid. 1998. Line harvest containers with mesh bags for washing. *Growing for Market*. December. p. 8.
- 14) Aylesworth, Jean. 1992. Deliver quality. *American Vegetable Grower*. June. p. 19-20.

## Enclosures:

---

Joyce, Daryl and Michael Reid. 1992. Postharvest handling of fresh culinary herbs. *Herbal Connection*. Vol. 2, No. 5. p. 7-9.

Brun, Charles A. 1994. On-farm refrigeration. *Pacific Northwest Sustainable Agriculture*. June. p. 4-5.

Nagangast, Dan. 1995. Low-cost cooler uses old air conditioner. *Growing for Market*. November. p. 14.

## Resources:

---

### Further Information

*Commercial Cooling of Fruits, Vegetables, and Flowers.*

By James Thompson, et al. 1998. 65 p.

University of California, ANR

Publications # 21567

*Detailed descriptions of proper temperature management for perishables and commercial cooling methods. Complete discussion of design for hydro-cooler and forced-air cooler systems, the two most commonly used cooling methods. 25 graphs and illustrations, 11 color plates, and 15 tables. Available for \$10 plus \$3.50 s/h. Make check payable to UC Regents and specify pub. #21567.*

University of California

ANR Communication Services

6701 San Pablo Avenue

Oakland, CA 94608-1239

(800) 994-8849

<http://anrcatalog.ucdavis.edu>

UC-Davis Produce Facts website

<http://postharvest.ucdavis.edu/Produce/ProduceFacts/index.html>

*Separate postharvest fact sheets for a great variety of fruit, vegetable, and ornamental crops. Each fact sheet includes information about maturity and quality indices, optimum temperature and relative humidity, rates of respiration and ethylene production rates, responses to ethylene and controlled atmospheres, physiological and pathological disorders: causes and control, and other relevant information. Periodic updates of these fact sheets will be published as new information becomes available. The goal is to eventually post fact sheets for all major perishable crops.*

*Perishables Handling*  
Editor: Pam Moyer  
Postharvest Technology  
Dept. of Pomology  
One Shields Ave.  
Univ. of California  
Davis, CA 95616-8683  
(530) 752-6941

*Perishables Handling, a quarterly publication from the UC-Davis Postharvest Outreach Program, reports research in progress, recent publications, and brief reviews of various aspects of postharvest technology of horticultural crops. A one-year subscription costs \$25. Back issues are available for \$8 each. Tables of contents of back issues may be reviewed on-line at:*  
<http://postharvest.ucdavis.edu/Pubs/POSTPhn.html>

*Produce Handling for Direct Marketing*  
Natural Resource, Agriculture, and Engineering Service (NRAES)  
1992. 26 p. NRAES-51.

*For growers selling seasonal produce at farmers' markets and roadside stands. Describes postharvest physiology, food safety, produce handling from harvest to storage, refrigeration, produce displays, and specific handling recommendations for over 40 fruits and vegetables. Includes eleven tables and eight figures.*

*Refrigeration and Controlled Atmosphere Storage for Horticultural Crops*  
1990. 44 p. NRAES-22

*General construction procedures for storage facilities: structural considerations, site selection, thermal insulation, vapor barriers, and attic ventilation. Explanations of various refrigeration systems, with descriptions of equipment and operating procedures. Controlled atmosphere storage construction, testing, and operation, especially in relation to apple storage.*

*Both of these NRAES publications are available, for \$8 each plus a total of \$3.75 s/h, from:*

NRAES  
Cooperative Extension  
152 Riley-Robb Hall  
Ithaca, NY 14853-5701  
(607) 255-7654  
<http://www.nraes.org>

*Postharvest Handling & Cooling of Fresh Fruits, Vegetables, and Flowers for Small Farms*  
By L.G. Wilson, M.D. Boyette, and E.A. Estes.  
1995. 17 p.

North Carolina Cooperative Extension Service.  
Leaflets 800-804.

*Five-part series: Quality Maintenance; Cooling; Handling; Mixed Loads; References. Available on-line at:*  
<http://www.ces.ncsu.edu/depts/hort/hil/post-index.html>

*North Carolina State University also offers the following fact sheets on postharvest cooling and handling, at:*  
[www5.bae.ncsu.edu/programs/extension/publicat/postharv/index.html](http://www5.bae.ncsu.edu/programs/extension/publicat/postharv/index.html)

Apples AG-413-1  
Strawberries AG-413-2  
Peppers AG-413-3  
Sweet Corn AG-413-4  
Cabbage and Leafy Greens AG-413-5  
Onions AG-413-6  
Blueberries AG-413-7  
Greenbeans and Field Peas AG-413-8  
Tomatoes AG-413-9  
Proper Postharvest Cooling and Handling Methods AG-414-1  
Design of Room Cooling Facilities AG-414-2  
Forced-Air Cooling AG-414-3  
Hydrocooling AG-414-4  
Crushed and Liquid Ice Cooling AG-414-5  
Chlorination and Postharvest Disease Control AG-414-6  
Cool and Ship: Low Cost Portable Forced Air Cool Unit AG-414-7  
Packaging Requirements for Fresh Fruits and Vegetables AG-414-8

*For information on ordering print copies of these publications, contact:*

North Carolina State University  
Dept. of Communication Services  
Box 7603  
Raleigh, NC 27695-7603  
(919) 515-2861

*Kansas State University offers the following publications on postharvest management of commercial horticultural crops. All are available on-line at:*  
<http://www.oznet.ksu.edu/library>

Containers and Packaging – Fruits and Vegetables MF979  
Fruits and Vegetables – Precooling Produce MF1002  
Harvest Maturity Indicators for Fruits and Vegetables MF1175

Storage Conditions – Fruits and Vegetables  
MF978  
Storage Construction MF1039  
Storage Operations MF1033  
Storage Options MF1030

*For information on ordering print copies, contact:*

Production Services  
Kansas State University  
24 Umberger Hall  
Manhattan, KS 66506-3402  
(785) 532-5830  
e-mail: [orderpub@oz.oznet.ksu.edu](mailto:orderpub@oz.oznet.ksu.edu)

The University of Wisconsin has produced a very helpful set of "Work Efficiency Tip Sheets" for fresh-market vegetable growers. These materials were developed by the Healthy Farmers, Healthy Profits Project, with the goal of sharing labor-efficiency practices that maintain farmers' health and safety while increasing profits. Topics in the series include:

**A Specialized Harvest Cart for Greens A3704-1**

*Stooping or kneeling and crawling to harvest salad greens requires a lot of time and energy. An alternative is to build a simple cart that allows you to sit and roll while you harvest. The cart also holds your harvest container, so it rolls along with you. Parts for the cart will cost about \$150.*

**Mesh Produce Bags: Easy Batch Processing A3704-2**

*Elements and benefits of the batch method for washing greens, as discussed above under the heading "Sanitation."*

**Standard Containers A3704-3**

*Standard containers for carrying and moving produce are made of molded plastic, have sturdy handles, and are stackable. They're easier to use and more efficient than bushel baskets, buckets or wooden crates.*

**Narrow Pallet System A3704-4**

*If you currently carry boxes of produce by hand, switching to a narrow pallet system may save you time and money. With a hand pallet truck you can move up to 16 half-bushel boxes at a time. This system can cut your time spent moving boxes by more than 60% and will dramatically reduce the stress put on your body.*

*These tipsheets may be ordered from the following address, or accessed on-line at:*  
<http://www.bse.wisc.edu/hfhp/>

Cooperative Extension Publishing  
Rm. 170, 630 W. Mifflin St.  
Madison, WI 53703  
(608) 262-3346  
<http://www.uwex.edu/ces/pubs/>

Sydney Postharvest Lab  
<http://www.postharvest.com.au>

*This Australian website offers postharvest handling and storage information, with extensive links to other postharvest sites.*

*Growing for Market*  
Editor: Lynn Byczynski  
P.O. Box 3747  
Lawrence, KS 66046  
(800) 307-8949

*This monthly newsletter is a great resource for small-scale growers. Lots of good, practical information from other producers, with frequent coverage of postharvest topics. Subscriptions cost \$30. for one year, or \$55. for two years.*

**Manufacturers & Suppliers**

**NOTE:** This list is intended to be neither comprehensive nor exclusive. Endorsement of any particular product or company is not implied.

*American Vegetable Grower*  
Meister Publishing Company  
37733 Euclid Ave.  
Willoughby, OH 44094  
(440) 942-2000

*The annual "Source Book" issue (July) is a comprehensive listing of manufacturers and suppliers of every type of product for farmers, including postharvest equipment and supplies. 12 issues/\$15.95. Single issue/\$2.75.*

Cady Industries  
P.O. Box 2087  
Memphis, TN 38101  
(800) 622-3695

*Sells a 32" x 27" McKnit nylon bag with 1/8" mesh for \$6 each, with a minimum order of 10.*

The Nylon Net Co.  
845 North Main St.  
Memphis, TN 38107  
(800) 238-7529

*Sells a 1/4" nylon mesh "diver's bag" with drawstring, 24" x 34", for \$8.28 each.*

Delta Track  
P.O. Box 398  
Pleasanton, CA 94566  
(800) 962-6776

*Sells "Hygro Thermometers": about the size of a deck of cards, battery operated, digital display of temperature and humidity, records daily min./max. of each.*

Spectrum Technologies  
23839 W. Andrews Rd.  
Plainfield, IL 60544  
(800) 248-8873

*Sells humidity monitors.*

Barr, Inc.  
1423 Planeview Dr.  
Oshkosh, WI 54904  
(920) 231-1711  
e-mail: info@barrinc.com  
<http://www.barrinc.com>

*Distributor of used coolers, freezers, and refrigeration systems.*

Cool Care Consulting, Inc.  
4020 Thor Dr.  
Boynton Beach, FL 33426  
(561) 364-5711  
e-mail: ron.roberts@coolcareinc.com  
<http://www.coolcareinc.com>

*Sells postharvest pre-cooling and refrigeration equipment, including forced air, ice, hydro, vacuum, modular, and mobile cooling units.*

Bio Safe Systems  
80 Commerce St.  
Glastonbury, CT 06033  
(888) 273-3088  
e-mail: Rob@biosafesystems.com  
<http://www.biosafesystems.com>

*Sells organic-approved, eco-friendly washwater treatments/disinfectants.*

The electronic version of **Postharvest Handling of Fruit & Vegetables** is located at:  
<http://www.attra.org/attra-pub/postharvest.html>

---

**By Janet Bachmann and Richard Earles**  
**NCAT Agriculture Specialists**

**August 2000**

The ATTRA Project is operated by the National Center for Appropriate Technology under a grant from the Rural Business-Cooperative Service, U.S. Department of Agriculture. These organizations do not recommend or endorse products, companies, or individuals. ATTRA is located in the Ozark Mountains at the University of Arkansas in Fayetteville at P.O. Box 3657, Fayetteville, AR 72702. ATTRA staff members prefer to receive requests for information about sustainable agriculture via the toll-free number 800-346-9140.

# APPENDIX I

Storage Conditions for Vegetables and Fruits					
	Temperature F	% Relative humidity	Precooling method	Storage life Days	Ethylene sensitive
Apples	30-40	90-95	R, F, H	90-240	Y
Apricots	32	90-95	R, H	7-14	Y
Asparagus	32-35	95-100	H, I	14-21	Y
Avocados	40-55	85-90		14-28	Y
Bananas	56-58	90-95		7-28	Y
Beans, snap	40-45	95	R, F, H	10-14	Y
Beans, lima	37-41	95		7-10	
Beets, roots	32	98-100	R	90-150	
Blackberries	31-32	90-95	R, F	2-3	
Blueberries	31-32	90-95	R, F	10-18	
Broccoli	32	95-100	I, F, H	10-14	Y
Brussel sprouts	32	95-100	H, V, I	21-35	Y
Cabbage	32	98-100	R, F	90-180	Y
Cantaloupe	36-41	95	H, F	10-14	Y
Carrots, topped	32	98-100	I, R	28-180	Y
Cauliflower	32	90-98	H, V	20-30	
Celery	32	98-100	I	14-28	Y
Cherries, sweet	30-31	90-95	H, F	14-21	
Corn, sweet	32	95-98	H, I, V	4-6	
Cranberries	36-40	90-95		60-120	
Cucumbers	50-55	95	F, H	10-14	Y
Eggplant	46-54	90-95	R, F	10-14	Y
Endive	32	90-95	H, I	14-21	Y
Garlic	32-34	65-75	N	90-210	
Grapefruit	50-60	85-90		28-42	
Grapes	32	85	F	56-180	
Kiwifruit	32	95-100		28-84	Y
Leeks	32	95-100	H, I	60-90	Y
Lemons	50-55	85-90		30-180	
Lettuce	32	85-90	H, I	14-21	Y
Limes	48-50	85-90		21-35	
Mushrooms	32	95		12-17	
Nectarines	31-32	95	F, H	14-18	Y
Okra	45-50	90-95		7-14	Y
Onions, bulb	32	65-70	N	30-180	
Onions, green	32	95-100	H, I	7-10	
Oranges	32-48	85-90		21-56	
Peaches	31-32	90-95	F, H	14-28	Y



	<b>Temperature F</b>	<b>% Relative humidity</b>	<b>Precooling method</b>	<b>Storage life Days</b>	<b>Ethylene sensitive</b>
Pears	32	90-95	F, R, H	60-90	Y
Peas, in pods	32	95-98	F, H, I	7-10	Y
Peppers, bell	45-55	90-95	R, F	12-18	Y
Peppers, hot	45-50	60-70	R, F	14-21	Y
Pineapple	45-55	85-90		14-36	
Plums	32	90-95	F, H	14-28	Y
Potatoes, early	50-60	90	R, F	56-140	
Potatoes, late	40-50	90	R, F	56-140	Y
Pumpkins	50-60	50-75	N	84-160	
Radishes	32	95-100	I	21-28	
Raspberries	32	90-95	R, F	2-3	Y
Rutabagas	32	98-100	R	120-180	
Spinach	32	95-100	H, I	10-14	Y
Squash, summer	41-50	95	R, F	7-14	Y
Squash, winter	50-55	50-70	N	84-150	
Strawberries	32	90-95	R, F	5-10	
Sweet potatoes	55-60	85-90	N	120-210	Y
Tangerines	40	90-95		14-28	
Tomatoes	62-68	90-95	R, F	7-28	Y
Turnips	32	95	R, H, V, I	120-150	
Watermelon	50-60	90	N	14-21	
F = forced-air cooling, H = hydrocooling, I = package icing, R = room cooling, V = vacuum cooling, N = no precooling needed. Sources: USDA Agricultural Marketing Service, Kansas State University Cooperative Extension Service					

## APPENDIX II

### The Portacooler

A portable precooler designed by USDA researchers can be built with readily available materials at a cost of around \$1,200. The most expensive component is an air conditioner. If a used air conditioner is available, the initial investment will be decreased. The Portacooler can be towed to the field and used to reduce field heat of berries, vegetables, and other high-value crops immediately after picking.

The structure of the Portacooler is a basic wood frame and plywood panel construction (see diagram). The outside dimensions of the cooler are 4 feet high by 4 feet wide by 8 feet long. The frame is made of 2 by 3's spaced 2 feet on center, excluding the doorway and the air conditioner space. The frames are sheathed with 1/2 inch plywood. The precooler is insulated with 2-inch thick plastic foam that fits firmly between the frame studs.

After the frame and sheathing are completed, the electrical components can be installed (see diagram). The standard junction box, power switches, daily cycle timer, and industrial thermostat control box should be mounted on the outside of the front wall near the air conditioner. An adjustable, industrial thermostat control box should be mounted on the outside of the front wall near the air conditioner. An adjustable, industrial thermostat must be connected to the air conditioner to replace the existing thermostat. Mount strip

heaters using copper wire so that they contact the cooling coils of the air conditioner. Mount the blower on the front inside wall, centered above the air conditioner so that the blower discharge is 12 inches below the inside ceiling.

All electrical components should be properly grounded, and wiring should comply with national and local electrical codes. Consult a licensed electrician for more information about how to install any components of the electrical system.

The Portacooler can be powered from either an electrical wall outlet or a gasoline-powered generator. The main electrical connection from the power source is split to the individual switches. From the switches, the power travels to the blower and to the air conditioner. The strip heaters and the thermostat are wired from the timer. The timer creates a defrost cycle by alternating power from the compressor to the strip heaters. (An interval of compressor shutdown time should be approximately 2.5 minutes during every 10 minutes.)

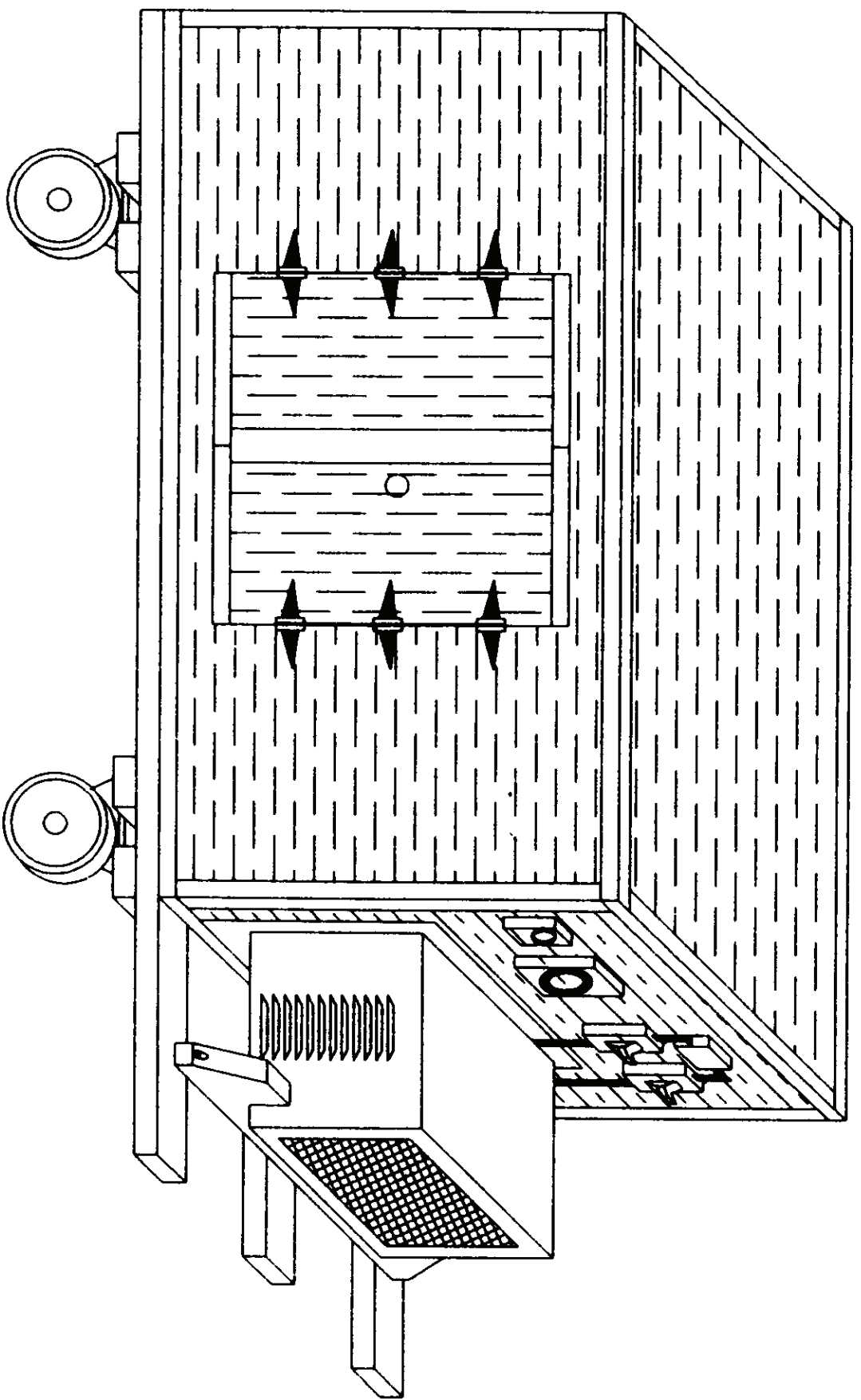
Once the cooler is assembled, and the electrical components hooked up, mount the air flow bulkhead. Mount the bulkhead with blower discharge hose flush with the edge of the blower discharge, allowing a 6-inch-high return-air gap along the floor.

All wood surfaces should be coated with polyurethane and an all-weather sealer to prolong the useful equipment life.

## General Material List

• air conditioner, 12,000 Btu, 115 V.....	1
• centrifugal blower, 1/3 hp, 1210 c.f.m. ....	1
• 20-amp wall switch, with boxes and covers .....	2
• 4 by 8 ft, exterior AC, 1/4-in plywood.....	11
• lumber, 2 by 3 in, 8 ft long.....	30
• lumber, 2 by 4 in, 12 ft long.....	3
• lumber, 2 by 6 in, 8 ft long.....	1
• industrial wheels, 5-in diameter.....	2
• industrial wheels, 5-in diameter, swivel.....	2
• dry wall screws, 2 1/2-in long.....	5 lb
• dry wall screws, 1-in long .....	1 lb
• water sealer .....	1 gal
• polyurethane coating .....	1 gal
• weather stripping, 1-in wide roll .....	1
• insulation, 2 in, 4 by 8 ft sheets.....	5
• 1/4-in plywood, 4-in wide strips .....	12 ft
• door latch, sliding bolt .....	1
• thermostat, 115 B, 16 amp, remote bulb .....	1
• strap hinges, screw fastened, 3-in long.....	4
• lumber, 2 by 10 in, 4 ft long.....	1
• standard junction box .....	1
• strip heaters, 150 watt, 8 in, 115 B.....	2
• insulated wire .....	30 ft
• cycle timer, SPDT, 115 B, 20 amp, 1 hour .....	1

The design, construction, and research of the Portacooler was conducted by Joseph Anthony, Gerald Berney, William Craig, and Daniel P. Schofer. For further information, contact Daniel Schofer, Room 1211 South Bldg., 12 & Independence, Box 96456, Washington, D.C. 20090-6456.



## Electrical Diagram

